PHYS 541 Radiative Processes

Spring 2022 Syllabus

Class website: http://spacibm.rice.edu/~liang/phys541 or on canvas

Instructor: Edison Liang, Room 342 Herman Brown Hall, x3524, email: liang@rice.edu

Office Hours: TuTh 12:30 – 2:30 pm, or by appointment

Class Time: TuTh 10:50 AM – 12:05 PM **Class Room:** HRZ 211

Textbooks:
Radiative Processes in Astrophysics, by George Rybicki and Alan Lightman (2004, Wiley paperback) (R&L)
The Physics of Astrophysics Vol.1: Radiation, Frank Shu (2010, University Science Books Paperback)

Supplemental References:
1. Classical Theory of Fields, L. Landau & E. Lifshitz (Oxford)
2. Classical Electrodynamics, J.D. Jackson (Wiley)
3. Radiative Processes in Plasmas, G. Bekefi (Wiley)
4. Radiation Processes in Astrophysics, W. Tucker (MIT)
5 Electromagnetic Processes, R. Gould (Princeton)
6. Quantum Theory of Radiation, W. Heitler (Dover)
7. Radiation in Astrophysical Plasmas, V. Zheleznyakov (Kluwer)
8. Stellar Atmospheres, D. Mihalas (Freeman)
9. Intermediate Quantum Mechanics, H. Bethe & R. Jackie (CRC Press).

Grades :
60% Home Works, 40% Term Paper or Final Project.
Home works are normally due 2 weeks after their assignment. Late home works will be discounted 25% for each lecture it is late, except for special hardship cases. Solutions will be posted on the class website after home works are graded.

Rice Honor Code:
Students are expected to uphold the Rice Honor Code. Students are allowed to work together on problem sets, but the submitted home works, term paper or final project must be his/her own original work.

Course Objectives:
This is a course on the fundamental physics of electromagnetic radiation processes. It has broad applications to all branches of physics, from astrophysics and space physics, to nuclear and particle physics, AMO and medical physics. While the core material is based on the textbook by Rybicki and Lightman, I plan to reduce somewhat the mathematical rigor and lengthy derivations of classical electromagnetic theory of the R & L textbook, and increase

the discussion of quantum radiation processes and their applications. I also plan to increase the coverage of atomic and molecular radiative processes and opacity. Other topics may also be added after mutual decision by the students and instructor.

Learning Outcomes:
Students are expected to turn in one homework assignment every two weeks, which will be graded, and complete a term paper or final project. Through home works, student should become fluent in solving problems in radiative processes and radiation transport, and master the key concepts of the textbooks and lecture material. The term paper will train students to develop skills in writing and literature search. If a final project is chosen in lieu of the term paper, it should consist of both conceptual and computational components.

Class Format:
The first two weeks of lectures will be remote only via Zoom. After that we plan to meet in person in HRZ 211, subject to any changes in University policy. All lecture recordings will be available on Zoom cloud through canvas.

Disability:
Any student with a documented disability that requires accommodation should contact both the course instructor and Disability Support Services in the Allen Center.

Title IX Responsible Employee Notification
Rice University cares about your wellbeing and safety. Rice encourages any student who has experienced an incident of harassment, pregnancy discrimination or gender discrimination or relationship, sexual, or other forms of interpersonal violence to seek support through The SAFE Office. Students should be aware when seeking support on campus that most employees, including myself, as the instructor, are required by Title IX to disclose all incidents of non- consensual interpersonal behaviors to Title IX professionals on campus who can act to support that student and meet their needs. For more information, please visit safe.rice.edu or email titleixsupport@rice.edu.

Tentative Topics and Number of Lectures

TOPIC	TENTATIVE NO. OF LECTURES	R & L Chapter
Introduction & organization	1	
Radiative transfer	2	1
Thermal radiation, diffusion, Einstein coefficients	2	1
Radiation Fields, polarization, Stokes parameters	2	2
Radiation from moving charges	1	3
Special Relativity	1	4
Bremsstrahlung (free-free) radiation	2	5
Synchrotron radiation	2	6
Thomson & Compton scattering	2	7
Pair Creation & Annihilation	1	
Medium effects	1	8
Atomic structure	2	9
Radiative transitions, Rayleigh & Raman scattering	4	10
Molecular structure	2	11
Stimulated emission, coherent radiation	1	
Other optional topics (TBD)	1	